

# Martin Heidegger

## MODERN SCIENCE, METAPHYSICS, AND MATHEMATICS

### A. The Characteristics of Modern Science in Contrast to Ancient and Medieval Science

One commonly characterizes modern science in contradistinction to medieval science by saying that modern science starts from facts while the medieval started from general speculative propositions and concepts. This is true in a certain respect. But it is equally undeniable that the medieval and ancient sciences also observed the facts and that modern science also works with universal propositions and concepts. This went so far that Galileo, one of the founders of modern science, suffered the same reproach that he and his disciples actually made against Scholastic science. They said it was "abstract," that is, that it proceeded with general propositions and principles. Yet in an even more distinct and conscious way the same was the case with Galileo. The contrast between the ancient and the modern attitude toward science cannot therefore be established by saying, there concepts and principles, and here facts. Both ancient and modern science have to do with both facts and concepts. However, the way the facts are conceived and how the concepts are established are decisive.

The greatness and superiority of natural science during the sixteenth and seventeenth centuries rests in the fact that all the scientists were philosophers. They understood that there are no mere

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facts, but that a fact is only what it is in the light of the fundamental conception, and always depends upon how far that conception reaches. The characteristic of positivism—which is where we have been for decades, today more than ever—by way of contrast is that it thinks it can manage sufficiently with facts, or other and new facts, while concepts are merely expedients which one somehow needs but should not get too involved with, since that would be philosophy. Furthermore, the comedy—or rather the tragedy—of the present situation of science is that one thinks to overcome positivism through positivism. To be sure, this attitude prevails only where average and supplemental work is done. Where genuine and discovering research is done the situation is no different from that of three hundred years ago. That age also had its indolence, just as, conversely, the present leaders of atomic physics, Niels Bohr and Heisenberg, think in a thoroughly philosophical way, and only therefore create new ways of posing questions and, above all, hold out in the questionable.

Hence it remains basically inadequate to try to distinguish modern from medieval science by calling it the science of facts. Further, the difference between the old and the new science is often seen in the fact that the latter experiments and proves “experimentally” its cognitions. But the experiment or test to get information concerning the behavior of things through a definite ordering of things and events was also already familiar in ancient times and in the Middle Ages. This kind of experience lies at the basis of all contact with things in the crafts and in the use of tools. Here too what matters is not the experiment as such in the wide sense of testing through observation but the manner of setting up the test and the intent with which it is undertaken and in which it is grounded. The manner of experimentation is presumably connected with the kind of conceptual determination of the facts and way of applying concepts, i.e., with the kind of preconception about things.

Besides these two constantly cited characteristics of modern sci-

ence, science of facts and experimental research, one also usually meets a third. This third affirms that modern science is a calculating and measuring investigation. That is true. However, it is also true of ancient science, which also worked with measurement and number. Again it is a question of how and in what sense calculating and measuring are applied and carried out, and what importance they have for the determination of the objects themselves.

With these three characteristics of modern science, that it is a factual, experimental, measuring science, we still miss the fundamental characteristic of modern science. The fundamental feature must consist in what rules and determines the basic movement of science itself. This characteristic is the manner of working with the things and the metaphysical projection of the thingness of the things. How are we to conceive this fundamental feature?

We attain this fundamental feature of modern science for which we are searching by saying that modern science is *mathematical*. From Kant comes the oft-quoted but still little understood sentence, “However, I maintain that in any particular doctrine of nature only so much *genuine* science can be found as there is mathematics to be found in it.” (Preface to *Metaphysical Beginning Principles of Natural Science*.)

The decisive question is: What do “mathematics” and “mathematical” mean here? It seems as though we can take the answer to this question only from mathematics itself. This is a mistake, because mathematics itself is only a particular formation of the mathematical. . . .

### B. The Mathematical, *Mathēsis*

How do we explain the mathematical if not by mathematics? In such questions we do well to keep to the word itself. Of course, the issue is not always there where the word occurs. But with the Greeks, from whom the word stems, we may safely make this assumption. In its formation the word “mathematical” stems from

the Greek expression *ta mathēmata*, which means what can be learned and thus, at the same time, what can be taught; *manthanein* means to learn, *mathēsis* the teaching, and this in a two-fold sense. First, it means studying and learning; then it means the doctrine taught. To teach and to learn are here intended in a wide and at the same time essential sense, and not in the later narrow and trite sense of school and scholars. However, this distinction is not sufficient to grasp the proper sense of the “mathematical.” To do this we must inquire in what further connection the Greeks employ the mathematical and from what they distinguish it.

We experience what the mathematical properly is when we inquire *under what* the Greeks classify the mathematical and *against what* they distinguish it within this classification. The Greeks identify the mathematical, *ta mathēmata*, in connection with the following determinations:

1. *Ta physica*: The things insofar as they originate and come forth from themselves.
2. *Ta poioumena*: The things insofar as they are produced by the human hand and stand as such.
3. *Ta chrēmata*: The things insofar as they are in use and therefore stand at our constant disposal—they may be either *physica*, rocks and so on, or *poioumena*, something specially made.
4. *Ta pragmata*: The things insofar as we have to do with them at all, whether we work on them, use them, transform them, or only look at and examine them, *pragmata* being related to *praxis*: here *praxis* is taken in a truly wide sense, neither in the narrow meaning of practical use (*chrēsthai*) nor in the sense of *praxis* as ethical action; *praxis* is all doing, pursuing, and sustaining, which also includes *poiesis*; and finally,
5. *Ta mathēmata*: According to the characterization running through these last four, we must also say here of *mathēmata*: The things insofar as they . . . but the question is: In what respect?

. . . We are long used to thinking of numbers when we think of the mathematical. The mathematical and numbers are obviously

connected. But the question remains: Is this connection due to the fact that the mathematical is numerical in character, or, on the contrary, is the numerical something mathematical? The second is the case. But insofar as numbers are in this way connected with the mathematical the question still remains: Why precisely are numbers something mathematical? What is the mathematical itself, that something like numbers must be conceived as mathematical and are primarily presented as the mathematical? *Mathēsis* means learning; *mathēmata*, what is learnable. In accord with what has been said, this designation is intended of things insofar as they are learnable. Learning is a kind of grasping and appropriating. But not every taking is a learning. We can take a thing, for instance, a rock, take it with us and put it in a rock collection. We can do the same with plants. It says in our cookbooks that one “takes,” i.e., uses. To take means in some way to take possession of a thing and have disposal over it. Now, what kind of taking is learning? *Mathēmata*—things, insofar as we learn them. . . .

The *mathēmata* are the things insofar as we take cognizance of them as what we already know them to be in advance, the body as the bodily, the plant-like of the plant, the animal-like of the animal, the thingness of the thing, and so on. This genuine learning is therefore an extremely peculiar taking, a taking where he who takes only takes what he basically already has. Teaching corresponds to this learning. Teaching is a giving, an offering; but what is offered in teaching is not the learnable, for the student is merely instructed to take for himself what he already has. If the student only takes over something that is offered he does not learn. He comes to learn only when he experiences what he takes as something he himself really already has. True learning occurs only where the taking of what one already has is a *self-giving* and is experienced as such. Teaching therefore does not mean anything else than to let the others learn, that is, to bring one another to learning. Teaching is more difficult than learning; for only he who can truly learn—and only as long as he can do it—can truly teach.

The genuine teacher differs from the pupil only in that he can learn better and that he more genuinely wants to learn. In all teaching, the teacher learns the most.

The most difficult learning is to come to know actually and to the very foundations what we already know. Such learning, with which we are here solely concerned, demands dwelling continually on what appears to be nearest to us, for instance, on the question of what a thing is. We steadfastly ask the *same* question—which in terms of utility is obviously useless—of what a thing is, what tools are, what man is, what a work of art is, what the state and the world are.

In ancient times there was a famous Greek scholar who traveled everywhere lecturing. Such people were called Sophists. This famous Sophist, returning to Athens once from a lecture tour in Asia Minor, met Socrates on the street. It was Socrates' habit to hang around on the street and talk with people, for example, with a cobbler about what a shoe is. Socrates had no other topic than what the things are. "Are you still standing there," condescendingly asked the much-traveled Sophist of Socrates, "and still saying the same thing about the same thing?" "Yes," answered Socrates, "that I am. But you who are so extremely smart, you *never* say the same thing about the same thing."

The *mathēmata*, the mathematical, is that "about" things which we really already know. Therefore we do not first get it out of things, but, in a certain way, we bring it already with us. From this we can now understand why, for instance, number is something mathematical. We see three chairs and say that there are three. What "three" is the three chairs do not tell us, nor three apples, three cats, nor any other three things. Rather, we can count three things only if we already know "three." In thus grasping the number three as such, we only expressly recognize something which, in some way, we already have. This recognition is genuine learning. The number is something in the proper sense learnable, a

*mathēma*, i.e., something mathematical. Things do not help us to grasp "three" as such, i.e., threeness. "Three"—what exactly is it? It is the number in the natural series of numbers that stands in third place. In "third"? It is only the third number because it is the three. And "place"—where do places come from? "Three" is not the third number, but the first number. "One" isn't really the first number. For instance, we have before us one loaf of bread and one knife, this one and, in addition, another one. When we take both together we say, "both of these," the one and the other, but we do not say, "these two," or  $1 + 1$ . Only when we add a cup to the bread and the knife do we say "all." Now we take them as a sum, i.e., as a whole and so and so many. Only when we perceive it from the third is the former one the first, the former other the second, so that one and two arise, and "and" becomes "plus," and there arises the possibility of places and of a series. What we now take cognizance of is not drawn from any of the things. We take what we ourselves somehow already have. What must be understood as mathematical is what we can learn in this way.

We take cognizance of all this and learn it without regard for the things. Numbers are the most familiar form of the mathematical because, in our usual dealing with things, when we calculate or count, numbers are the closest to that which we recognize in things without deriving it from them. For this reason numbers are the most familiar form of the mathematical. In this way, this most familiar mathematical becomes mathematics. But the essence of the mathematical does not lie in number as purely delimiting the pure "how much," but vice versa. Because number has such a nature, therefore, it belongs to the learnable in the sense of *mathēsis*.

Our expression "the mathematical" always has two meanings. It means, first, what can be learned in the manner we have indicated, and only in that way, and, second, the manner of learning and the process itself. The mathematical is that evident aspect of things

within which we are always already moving and according to which we experience them as things at all, and as such things. The mathematical is this fundamental position we take toward things by which we take up things as already given to us, and as they must and should be given. Therefore, the mathematical is the fundamental presupposition of the knowledge of things.

Therefore, Plato put over the entrance to his Academy the words: *Ageometrētos mēdeis eisito!* "Let no one who has not grasped the mathematical enter here!"\* These words do not mean that one must be educated in only one subject—"geometry"—but that he must grasp that the fundamental condition for the proper possibility of knowing is the knowledge of the fundamental presuppositions of all knowledge and the position we take based on such knowledge. A knowledge which does not build its foundation knowledgeably, and thereby takes its limits, is not knowledge but mere opinion. The mathematical, in the original sense of learning what one already knows, is the fundamental presupposition of "academic" work. This saying over the Academy thus contains nothing more than a hard condition and a clear circumscription of work. Both have had the consequence that we today, after two thousand years, are still not through with this academic work and never will be as long as we take ourselves seriously.

This brief reflection on the essence of the mathematical was brought about by our maintaining that the basic character of modern science is the mathematical. After what has been said, this cannot mean that this science employs mathematics. Our inquiry showed that, *in consequence* of this basic character of science, mathematics in the narrower sense first had to come into play.

Therefore, we must now show in what sense the foundation of modern thought and knowledge is essentially mathematical. With this intention we shall try to set forth an essential step of modern

\* Elias Philosophus, sixth century A.D. Neoplatonist, in *Aristotelis Categorias Commentaria (Commentaria in Aristotelem Graeca)*, A. Busse, ed. (Berlin, 1900), 118.18.—TR.

science in its main outline. This will make clear what the mathematical consists of and how it thus unfolds its essence, but also becomes established in a certain direction.

### C. The Mathematical Character of Modern Natural Science; Newton's First Law of Motion

Modern thought does not appear all at once. Its beginnings stir during the later Scholasticism of the fifteenth century; the sixteenth century brings sudden advances as well as setbacks; but it is only during the seventeenth century that the decisive clarifications and foundations are accomplished. This entire happening finds its first systematic and creative culmination in the English mathematician and physicist Newton, in his major work, *Philosophiae Naturalis Principia Mathematica*, 1686–87. In the title, "philosophy" indicates general science (compare "*Philosophia experimentalis*"); "*principia*" indicates first principles, the beginning ones, i.e., the *very first* principles. But these starting principles by no means deal with an introduction for beginners.

This work was not only a culmination of preceding efforts, but at the same time the foundation for the succeeding natural science. It has both promoted and limited the development of natural science. When we talk about classical physics today, we mean the form of knowledge, questioning, and evidence as Newton established it. When Kant speaks of "science," he means Newton's physics. . . .

This work is preceded by a short section entitled "*Definitiones*." These are definitions of *quantitas materiae*, *quantitas motus*, force, and, above all, *vis centripeta*. Then there follows an additional *scholium* which contains the series of famous conceptions of absolute and relative time, absolute and relative space, and finally of absolute and relative motion. Then follows a section with the title "*Axiomata, sive leges motus*" ("Principles or Laws of Motion"). This contains the proper content of the work. It is divided into

three volumes. The first two deal with the motion of bodies, *de motu corporum*, the third with the system of the world, *de mundi systemate*.

Here we shall merely take a look at the first principle, i.e., that Law of Motion which Newton sets at the apex of his work. . . . "Every body continues in its state of rest, or uniform motion in a straight line, unless it is compelled to change that state by force impressed upon it."\* This is called the principle of inertia (*lex inertiae*).

The second edition of this work was published in 1713, while Newton was still alive. It included an extended preface by Cotes, then professor at Cambridge. In it Cotes says about this basic principle: "It is a law of nature universally received by all philosophers."

Students of physics do not puzzle over this law today and have not for a long time. If we mention it at all and know anything about it, that and to what extent it is a fundamental principle, we consider it self-evident. And yet, one hundred years before Newton at the apex of his physics put this law in this form, it was still unknown. It was not even Newton himself who discovered it, but Galileo; the latter, however, applied it only in his last works and did not even express it as such. Only the Genoese Professor Baliani articulated this discovered law in general terms. Descartes then took it into his *Principia Philosophiae* and tried to ground it metaphysically. With Leibniz it plays the role of a metaphysical law (C. I. Gerhardt, *Die philosophischen Schriften von G. W. Leibniz* [Berlin, 1875–1890], IV, 518, *contra Bayle*).

This law, however, was not at all self-evident even in the seventeenth century. During the preceding fifteen hundred years it was not only unknown, but nature and beings in general were experienced in such a way that it would have been senseless. In its

discovery and its establishment as the fundamental law lies a revolution that belongs to the greatest in human thought, and which first provides the ground for the turning from the Ptolemaic to the Copernican conception of the universe. To be sure, the law of inertia and its definition already had their predecessors in ancient times. Certain fundamental principles of Democritus (460–370 b.c.) tend in this direction. It has also been shown that Galileo and his age (partly directly and partly indirectly) knew of the thought of Democritus. But, as is always the case, that which can already be found in the older philosophers is seen only when one has newly thought it out for himself. . . . After people understood Democritus with the help of Galileo they could reproach the latter for not really reporting anything new. All great insights and discoveries are not only usually thought by several people at the same time, they must also be rethought in that unique effort to truly say the same thing about the same thing.

#### D. The Difference Between the Greek Experience of Nature and That of Modern Times

##### 1. *The experience of nature in Aristotle and Newton*

How does the aforementioned fundamental law relate to the earlier conception of nature? The idea of the universe (world) which reigned in the West up to the seventeenth century was determined by Platonic and Aristotelian philosophy. Scientific conceptual thought especially was guided by those fundamental representations, concepts and principles which Aristotle had set forth in his lectures on physics and the heavens (*De Caelo*), and which were taken over by the medieval Scholastics.

We must, therefore, briefly go into the fundamental conceptions of Aristotle in order to evaluate the significance of the revolution articulated in Newton's First Law. But we must first liberate ourselves from a prejudice which was partly nourished by modern

\* Isaac Newton, *Mathematical Principles of Natural Philosophy and His System of the World*, Andrew Motte, trans., 1729; revised translation, Florian Cajori (Berkeley: University of California Press, 1946), p. 13.—Tr.

science's sharp criticism of Aristotle: that his propositions were merely concepts he thought up, which lacked any support in the things themselves. This might be true of later medieval Scholasticism, which often in a purely dialectical way was concerned with a foundationless analysis of concepts. It is certainly not true of Aristotle himself. Moreover, Aristotle fought in his time precisely to make thought, inquiry, and assertion always a *legein homologoumena tois phainomenois*, "saying what corresponds to that which shows itself in beings" (*De caelo*, III, 7, 306a 6).

In the same place Aristotle expressly says: *telos de tēs men poiētikēs epistēmēs to ergon, tēs de physikēs to phainomenon aei kuriōs kata tēn aisthēsin.* ["And that issue, which in the case of productive knowledge is the product, in the knowledge of nature is the unimpeachable evidence of the senses as to each fact."\*] We have heard (p. 250, above) that the Greeks characterize the thing as *physica* and *poioumena*, such as occurs from out of itself, or such as is produced. Corresponding to this, there are two different kinds of knowledge (*epistēmē*), knowledge of what occurs from out of itself and knowledge of what is produced. Corresponding to this, the *telos* of knowledge, that is, that whereby this knowledge comes to an end-point, where it stops, *what it genuinely holds to*, is different. Therefore the above sentence states, "That at which productive knowledge comes to a halt, where from the beginning it takes hold, is the *work* to be produced. That, however, in which the knowledge of 'nature' takes hold is to *phainomenon*, what shows itself in that which occurs out of itself. This is always predominant and is the standard, especially for perception, that is, for mere 'taking-in-and-up'" (in contradistinction to making and concerning oneself busily with creation of things). What Aristotle here expresses as a basic principle of scientific method differs in no way from the principles of modern science. Newton writes (*Prin-*

\* *De caelo*, III, 7, 306a 16–17. The translation is taken from *The Works of Aristotle*, W. D. Ross, ed. and trans., 11 vols. (Oxford: Clarendon Press, 1931).—TR.

*cipia*, Bk. III, *Regulae* IV): . . . "In experimental philosophy we are to look upon propositions inferred by general induction from phenomena as accurate or very nearly true, notwithstanding contrary hypotheses that may be imagined, till such times as other phenomena occur, by which they may either be made more accurate, or liable to exceptions."

But despite this similar basic attitude toward procedure, the basic position of Aristotle is essentially different from that of Newton. For *what* is actually apprehended as appearing and *how* it is interpreted are not alike.

## 2. The doctrine of motion in Aristotle

Nevertheless, they share from the start the experience that beings, in the general sense of nature—earth, sky, and stars—are in motion or at rest. Rest means only a special case of motion. It is everywhere a question of the motion of bodies. But how motion and bodies are to be conceived and what relation they have to each other is not established and not self-evident. From the general and indefinite experience that things change, come into existence and pass away, thus are in motion, it is a long way to an insight into the essence of motion and into the manner of its belonging to things. The ancient Greek conception of the earth is of a disc around which floats Okeanos. The sky overarches it and turns around it. Later Plato, Aristotle, and Eudoxus—though each differently—present the earth as a ball, but still as a center of everything.

We restrict ourselves to the presentation of the Aristotelian conception which later became widely dominant, and this only sufficiently to show the contrast which expresses itself in the first axiom of Newton.

First, we ask in general what, according to Aristotle, is the essence of a thing in nature? The answer is: *ta physica sōmata* are *kath' auta kinēta kata topon*. "Those bodies which belong to 'nature' and constitute it are, in themselves, movable with respect to

location." Motion, in general, is *metabolē*, the alteration of something into something else. Motion in this wide sense includes, for instance, turning pale or blushing. But it is also an alteration when a body is transferred from one place to another. This being transported, altered, or conveyed is expressed in Greek as *phora*. *Kinēsis kata topōn* means in Greek what constitutes the proper motion of Newtonian bodies: In this motion lies a definite relation to place. The motion of bodies, however, is *kath' auta*, according to them, themselves. That is to say, how a body moves, i.e., how it relates to place and to which place it relates—all this has its basis in the body itself. This basis is *archē*, which has a double meaning: that from which something emerges, and that which governs over what emerges in this way. The body is *archē kinēseōs*. What an *arche kineseos* in this manner is, is *physis*, the original mode of emergence, which, however, remains limited solely to pure movement in space. Herein appears an essential transformation of the concept of *physis*. The body moves according to its nature. A moving body, which is itself an *archē kinēseōs*, is a natural body. The purely earthly body moves downward, the purely fiery body—as every blazing flame demonstrates—moves upward. Why? Because the earthly has its place below, the fiery, above. Each body has its place according to its kind, and it strives toward that place. Around the earth is water, around this, the air, and around this, fire—the four elements. When a body moves toward its place this motion accords with nature, *kata physin*. A rock falls down to the earth. However, if a rock is thrown upward by a sling, this motion is essentially against the nature of the rock, *para physin*. All motions against nature are *bīai*, violent.

The kind of motion and place of the body are determined according to the nature of the body. Earth is the center for all characterization and evaluation of motion. The rock that falls moves toward this center, *epi to meson*. The fire that rises, *apo tou mesou*, moves away from the center. In both cases the motion is *kinēsis eutheia*, in a straight line. But the stars and the entire

heavens move around the center, *peri to meson*. This motion is *kykloī*. Circular motion and motion in a straight line are the simple movements, *haplai*. Of these two, circular motion is first, i.e., is the higher, and thus, of the highest order. For *proteron to teleion tou atelous*, the complete precedes the incomplete. The motion of bodies accords with their place. In circular motion the body has its place in the motion itself; for this reason such motion is perpetual and truly in being. In rectilinear motion the place lies only in one direction, away from another place, so that motion comes to an end over there. Besides these two forms of simple motion there are mixtures of both, *miktē*. The purest motion, in the sense of change of place, is circular motion; it contains, as it were, its place in itself. A body that so moves itself, moves itself completely. This is true of all celestial bodies. Compared to this, earthly motion is always in a straight line, or mixed, or violent, but always incomplete.

There is an essential difference between the motion of celestial bodies and earthly bodies. The domains of these motions are different. How a body moves depends upon its species and the place to which it belongs. The *where* determines the *how* of its Being, for Being means *presence* [Anwesenheit]. Because it moves in a circle, that is, moves completely and permanently in the simplest motion, the moon does not fall earthward. This circular motion is in itself completely independent of anything outside itself—for instance, from the earth as center. But, by way of contrast, to anticipate, in modern thought circular motion is understood only in such a way that a perpetual attracting force from the center is necessary for its formation and preservation. With Aristotle, however, this "force," *dynamis*, the capacity for its motion, lies in the *nature* of the body itself. The kind of motion of the body and its relation to its place depend upon the nature of the body. The velocity of natural motion increases the nearer the body comes to its place; that is, increase and decrease of velocity and cessation of motion depend upon the nature of the body. A motion contrary to

nature, i.e., violent motion, has its cause in the force that affects it. However, according to its motion, the body, driven forcibly, must withdraw from this power, and since the body itself does not bring with it any basis for this violent motion, its motion must necessarily become slower and finally stop (cf. *De caelo*, I, 8, 277b 6; I, 2, 269b 9).

This corresponds distinctly to the common conception: a motion imparted to a body continues for a certain time and then ceases, passing over into a state of rest. Therefore we must look for the causes of the continuation or endurance of the motion. According to Aristotle the basis for natural motion lies in the nature of the body itself, in its essence, in its most proper Being. A later Scholastic proposition is in accord with this: *Operari (agere) sequitur esse*. "The kind of motion follows from the kind of Being."

### 3. Newton's doctrine of motion

How do Aristotle's observation of nature and concept of motion as we have described them relate to the modern ones, which got an essential foundation in the first axiom of Newton? We shall try to present in order a few main distinctions. For this purpose we give the axiom an abridged form: "Every body left to itself moves uniformly in a straight line." *Corpus omne, quod a viribus impressis non cogitur, uniformiter in directum movetur*. We shall discuss what is new in eight points.

1. Newton's axiom begins with *corpus omne*, "every body." That means that the distinction between earthly and celestial bodies has become obsolete. The universe is no longer divided into two well-separated realms, the one beneath the stars, the other the realm of the stars themselves. All natural bodies are essentially of the same kind. The upper realm is not a superior one.

2. In accord with this, the priority of circular motion over motion in a straight line also disappears. And although now, on the

contrary, motion in a straight line becomes decisive, still this does not lead to a division of bodies and of different domains according to their kind of motion.

3. Accordingly, the distinguishing of certain places also disappears. Each body can in principle be in any place. The concept of place itself is changed: place no longer is where the body belongs according to its inner nature, but only a position in relation to other positions. (Cf. points 5 and 7.) *Phora* and change of place in the modern sense are not the same.

With respect to the causation and determination of motion, one does not ask for the cause of the continuity of motion and therefore for its perpetual occurrence, but the reverse: being in motion is presupposed, and one asks for the causes of a change in the kind of motion presupposed as uniform and in a straight line. The circularity of the moon's motion does not cause its uniform perpetual motion around the earth. Precisely the reverse. It is this motion for whose cause we must search. According to the law of inertia, the body of the moon should move from every point of its circular orbit in a straight line, i.e., in the form of a tangent. Since the moon does not do so, the question—based upon the presupposition of the law of inertia—arises: Why does the moon decline from the line of a tangent? Why does it move, as the Greeks put it, in a circle? The circular movement is now not cause but, on the contrary, precisely what requires a reason. (We know that Newton arrived at a new answer when he proposed that the force according to which bodies fall to the ground is also the one according to which the celestial bodies remain in their orbits: gravity. Newton compared the centripetal declination of the moon from the tangent of its orbit during a fraction of time with this linear distance which a falling body achieves at the surface of earth in an equal time. At this point we see immediately the elimination of the distinction already mentioned between earthly and celestial motions and thus between bodies.)

4. Motions themselves are not determined according to different natures, capacities, and forces, or the elements of the body, but, in reverse, the essence of force is determined by the fundamental law of motion: every body, left to itself, moves uniformly in a straight line. According to this, a force is that whose impact results in a declination from rectilinear, uniform motion. "An impressed force is an action exerted upon a body, in order to change its state, either of rest, or of uniform motion in a right line." (*Principia*, Def. IV). This new determination of force leads at the same time to a new determination of mass.

5. Corresponding to the change of the concept of place, motion is seen only as a change of position and relative position, as distances between places. Therefore the determination of motion develops into one regarding distances, stretches of the measurable, of the so and so large. Motion is determined as the amount of motion, and, similarly, mass as weight.

6. Therefore the difference between natural and against nature, i.e., violent, is also eliminated; the *bia*, violence, is as force only a measure of the change of motion and is no longer special in kind. Impact, for instance, is only a particular form of impressed force, along with pressure and centripetality.

7. Therefore the concept of nature in general changes. Nature is no longer the *inner* principle out of which the motion of the body follows; rather, nature is the mode of the variety of the changing relative positions of bodies, the manner in which they are present in space and time, which themselves are domains of possible positional orders and determinations of order and have no special traits anywhere.

8. Thereby the manner of questioning nature also changes and, in a certain respect, becomes opposite.

We cannot set forth here the full implications of the revolution of inquiry into nature. It should have become clear only that, and how, the application of the First Law of Motion implies all the

essential changes. All these changes are linked together and uniformly based on the new basic position expressed in the First Law and which we call mathematical.

### E. The Essence of the Mathematical Project [*Entwurf*]\* (Galileo's Experiment with Free Fall)

For us, for the moment, the question concerns the application of the First Law, more precisely, the question in what sense the mathematical becomes decisive in it.

How about this law? It speaks of a body, *corpus quod a viribus impressis non cogitur*, a body which is left to itself. Where do we find it? There is no such body. There is also no experiment which could ever bring such a body to direct perception. But modern science, in contrast to the mere dialectical poetic conception of medieval Scholasticism and science, is supposed to be based upon experience. Instead, it has such a law at its apex. This law speaks of a thing that does not exist. It demands a fundamental representation of things which contradict the ordinary.

The mathematical is based on such a claim, i.e., the application of a determination of the thing which is not experientially derived from the thing and yet lies at the base of every determination of the things, making them possible and making room for them. Such a fundamental conception of things is neither arbitrary nor self-evident. Therefore, it required a long controversy to bring it into

\* Perhaps the best insight as to what Heidegger means by *Entwurf* is Kant's use of the word in the *Critique of Pure Reason*. "When Galileo experimented with balls whose weight he himself had already predetermined, when Torricelli caused the air to carry a weight which he had calculated beforehand to be equal to that of a definite column of water, or, at a later time, when Stahl converted metal into lime and this again into metal by withdrawing something and then adding it, a light broke in on all investigators of nature. They learned that reason only gains insight into what it produces itself according to its own projects [was sie selbst nach ihrem Entwurfe hervorbringt]; that it must go before with principles of judgment according to constant laws, and constrain nature to reply to its questions, not content merely to follow her leading-strings" (B XIII).—Tr.

power. It required a change in the mode of approach to things along with the achievement of a new manner of thought. We can accurately follow the history of this battle. Let us cite one example from it. In the Aristotelian view, bodies move according to their nature, the heavy ones downward, the light ones upward. When both fall, heavy ones fall faster than light ones, since the latter have the urge to move upward. It becomes a decisive insight of Galileo that all bodies fall equally fast, and that the differences in the time of fall derive only from the resistance of the air, not from the different inner natures of the bodies or from their own corresponding relation to their particular place. Galileo did his experiment at the leaning tower in the town of Pisa, where he was professor of mathematics, in order to prove his statement. In it bodies of different weights did not arrive at precisely the same time after having fallen from the tower, but the difference in time was slight. In spite of these differences and therefore really *against* the evidence of experience, Galileo upheld his proposition. The witnesses to this experiment, however, became really perplexed by the experiment and Galileo's upholding his view. They persisted the more obstinately in their former view. By reason of this experiment the opposition toward Galileo increased to such an extent that he had to give up his professorship and leave Pisa.

Both Galileo and his opponents saw the same "fact." But they interpreted the same fact differently and made the same happening visible to themselves in different ways. Indeed, what appeared for them as the essential fact and truth was something different. Both thought something along with the same appearance but they thought something different, not only about the single case, but fundamentally, regarding the essence of a body and the nature of its motion. What Galileo thought in advance about motion was the determination that the motion of every body is uniform and rectilinear, when every obstacle is excluded, but that it also changes uniformly when an equal force affects it. In his *Discorsi*, which appeared in 1638, Galileo said: "I think of a body thrown on a

horizontal plane and every obstacle excluded. This results in what has been given a detailed account in another place, that the motion of the body over this plane would be uniform and perpetual if the plane were extended infinitely."

In this proposition, which may be considered the antecedent of the First Law of Newton, what we have been looking for is clearly expressed. Galileo says: *Mobile . . . mente concipio omni secluso impedimento*. "I think in my mind of something moveable that is left entirely to itself." This "to think in the mind" is that giving oneself a cognition about a determination of things. It is a procedure of going ahead in advance, which Plato once characterized regarding *mathēsis* in the following way: *analabōn autos ex autou tēn epistēmēn* (*Meno* 85d), "bringing up and taking up—above and beyond the other—taking the knowledge itself from out of himself."

There is a prior grasping together in this *mente concipere* of what should be uniformly determinative of each body as such, i.e., for being bodily. All bodies are alike. No motion is special. Every place is like every other, each moment like any other. Every force becomes determinable only by the change of motion which it causes—this change in motion being understood as a change of place. All determinations of bodies have one basic blueprint, according to which the natural process is nothing but the space-time determination of the motion of points of mass. This fundamental design of nature at the same time circumscribes its realm as everywhere uniform.

Now if we summarize at a glance all that has been said, we can grasp the essence of the mathematical more sharply. Up to now we have stated only its general characteristic, that it is a taking cognizance of something, what it takes being something it gives to itself from itself, thereby giving to itself what it already has. We now summarize the fuller essential determination of the mathematical in a few separate points:

1. The mathematical is, as *mente concipere*, a project of thing-

ness which, as it were, skips over the things. The project first opens a domain where things—i.e., facts—show themselves.

2. In this projection is posited that which things are taken as, what and how they are to be evaluated beforehand. Such evaluation and taking-for is called in Greek *axiōō*. The anticipating determinations and assertions in the project are *axiōmata*. Newton therefore entitles the section in which he presents the fundamental determinations about things as moved *Axiomata, sive leges motus* [The Axioms or Laws of Motion]. The project is axiomatic. Insofar as every science and cognition is expressed in propositions, the cognition which is taken and posited in the mathematical project is of such a kind as to set things upon their foundation in advance. The axioms are *fundamental* propositions.

3. As axiomatic, the mathematical project is the anticipation of the essence of things, of bodies; thus the basic blueprint of the structure of every thing and its relation to every other thing is sketched in advance.

4. This basic plan at the same time provides the measure for laying out the realm which in the future will encompass all things of that sort. Now nature is no longer an inner capacity of a body, determining its form of motion and its place. Nature is now the realm of the uniform space-time context of motion, which is outlined in the axiomatic project and in which alone bodies can be bodies as a part of it and anchored in it.

5. The realm of nature, axiomatically determined in outline by this project, now also requires for the bodies and corpuscles within it a *mode of access* appropriate to the axiomatically predetermined objects. The mode of questioning and the cognitive determination of nature are now no longer ruled by traditional opinions and concepts. Bodies have no concealed qualities, powers, and capacities. Natural bodies are now only what they show themselves as, within this projected realm. Things now show themselves only in the relations of places and time points and in the measures of mass and working forces. How they show themselves is prefigured in the

project. Therefore the project also determines the mode of taking in and studying of what shows itself, experience, the *experiē*. However, because inquiry is now predetermined by the outline of the project, a line of questioning can be instituted in such a way that it poses conditions in advance to which nature must answer in one way or another. Upon the basis of the mathematical, the *experiēntia* becomes the modern experiment. Modern science is experimental because of the mathematical project. The experimenting urge to the facts is a necessary consequence of the preceding mathematical skipping of all facts. But where this skipping ceases or becomes weak, mere facts as such are collected, and positivism arises.

6. Because the project establishes a uniformity of all bodies according to relations of space, time, and motion, it also makes possible and requires a universal uniform measure as an essential determinant of things, i.e., numerical measurement. The mathematical project of Newtonian bodies leads to the development of a certain “mathematics” in the narrow sense. The new form of modern science did not arise because mathematics became an essential determinant. Rather, that mathematics, and a particular kind of mathematics, could come into play and had to come into play is a consequence of the mathematical project. The founding of analytical geometry by Descartes, the founding of the infinitesimal calculus by Newton, the simultaneous founding of the differential calculus by Leibniz—all these novelties, this mathematical in a narrower sense, first became possible and above all necessary on the grounds of the basically mathematical character of the thinking.

We would certainly fall into great error if we were to think that with this characterization of the reversal from ancient to modern natural science, and with this sharpened essential outline of the mathematical, we had already gained a picture of the actual science itself.

What we have been able to cite is only the fundamental outline

along which there unfolds the entire realm of posing questions and experiments, establishing laws, and disclosing new regions of beings. Within this fundamental mathematical position the questions about the nature of space and time, motion and force, body and matter remain open. These questions now receive a new sharpness; for instance, the question whether motion is sufficiently formulated by the designation "change of location." Regarding the concept of force, the question arises whether it is sufficient to represent force only as a cause that is effective only from the outside. Concerning the basic law of motion, the law of inertia, the question arises whether this law is not to be subordinated under a more general one, i.e., the law of the conservation of energy which is now determined in accordance with its *expenditure* and *consumption*, as *work*—names for new basic representations which now enter into the study of nature and betray a notable accord with economics, with the "calculation" of success. All this develops within and according to the fundamental mathematical position. What remains questionable in all this is a closer determination of the relation of the mathematical in the sense of mathematics to the intuitive experience of the given things and to these things themselves. Up to this hour such questions have been open. Their questionability is concealed by the results and the progress of scientific work. One of these burning questions concerns the justification and limits of mathematical formalism in contrast to the demand for an immediate return to intuitively given nature.

If we have grasped some of what has been said up till now, then it is understandable that the question cannot be decided by way of an either/or, either formalism or immediate intuitive determination of things; for the nature and direction of the mathematical project participate in deciding their possible relation to the intuitively experienced and vice versa. Behind this question concerning the relation of mathematical formalism to the intuition of nature stands the fundamental question of the justification and limits of

the mathematical in general, within a fundamental position we take toward beings as a whole. But in this regard the delineation of the mathematical has gained an importance for us.

#### F. The Metaphysical Meaning of the Mathematical

To reach our goal, the understanding of the mathematical we have gained by now is not sufficient. To be sure, we shall now no longer conceive of it as a generalization of the procedure of a particular mathematical discipline, but rather the particular discipline as a special form developing from the mathematical. But this mathematical must, in turn, be grasped from causes that lie even deeper. We have said that it is a fundamental trait of modern thought. Every sort of thought, however, is always only the execution and consequence of a mode of historical Dasein, of the fundamental position taken toward Being and toward the way in which beings are manifest as such, i.e., toward truth. . . .

##### 1. *The principles: new freedom, self-binding, and self-grounding*

We inquire, therefore, about the metaphysical meaning of the mathematical in order to evaluate its importance for modern metaphysics. We divide the question into two subordinate ones: (1) What new fundamental position of Dasein shows itself in this rise of the dominance of the mathematical? (2) How does the mathematical, according to its own inner direction, drive toward an ascent to a metaphysical determination of Dasein?

The second question is the more important for us. We shall answer the first one only in the merest outline.

Up to the distinct emergence of the mathematical as a fundamental characteristic of thought, the authoritative truth was considered that of Church and faith. The means for the proper knowledge of beings were obtained by way of the interpretation of the sources of revelation, the writ and the tradition of the Church. Whatever more experience and knowledge had been won adjusted

itself (as if by itself) to this frame. For basically there was no worldly knowledge. The so-called natural knowledge not based upon any revelation therefore did not have its own form of intelligibility or grounds for itself, let alone from out of itself. Thus, what is decisive for the history of science is not that all truth of natural knowledge was measured by the supernatural. Rather, it is that this natural knowledge, disregarding this criterion, arrived at no independent foundation and character out of itself. For the taking over of the Aristotelian syllogism cannot be reckoned as such.

In the essence of the mathematical, as the project we delineated, lies a specific will to a new formation and self-grounding of the form of knowledge as such. The detachment from revelation as the first source for truth and the rejection of tradition as the authoritative means of knowledge—all these rejections are only negative consequences of the mathematical project. He who dared to project the mathematical project put himself as the projector of this project upon a base which is first projected only in the project. There is not only a liberation in the mathematical project, but also a new experience and formation of freedom itself, i.e., a binding with obligations which are self-imposed. In the mathematical project develops an obligation to principles demanded by the mathematical itself. According to this inner drive, a liberation to a new freedom, the mathematical strives out of itself to establish its own essence as the ground of itself and thus of all knowledge.

Therewith we come to the second question: How does the mathematical, according to its own inner drive, move toward an ascent to a metaphysical determination of Dasein? We can abridge this question as follows: In what way does modern metaphysics arise out of the spirit of the mathematical? It is already obvious from the form of the question that mathematics could not become the standard of philosophy, as if mathematical methods were only appropriately generalized and then transferred to philosophy.

Rather, modern natural science, modern mathematics, and

modern metaphysics sprang from the same root of the mathematical in the wider sense. Because metaphysics, of these three, reaches farthest—to beings in totality—and because at the same time it also reaches deepest toward the Being of beings as such, therefore it is precisely metaphysics which must dig down to the bedrock of its mathematical base and ground. . . .

## 2. Descartes: Cogito Sum; "I" as a special subject

Modern philosophy is usually considered to have begun with Descartes (1596–1650), who lived a generation after Galileo. Contrary to the attempts which appear from time to time to have modern philosophy begin with Meister Eckhart or in the time between Eckhart and Descartes, we must adhere to the usual beginning. The only question is how one understands Descartes' philosophy. It is no accident that the philosophical formation of the mathematical foundation of modern Dasein is primarily achieved in France, England, and Holland any more than it is accidental that Leibniz received his decisive inspiration from there, especially during his sojourn in Paris from 1672–76. Only because he passed through that world and truly appraised its greatness in greater reflection was he in a position to lay the first foundation for its overcoming.

The following is the usual image of Descartes and his philosophy: During the Middle Ages philosophy stood—if it stood independently at all—under the exclusive domination of theology and gradually degenerated into a mere analysis of concepts and elucidations of traditional opinions and propositions. It petrified into an academic knowledge which no longer concerned man and was unable to illuminate reality as a whole. Then Descartes appeared and liberated philosophy from this disgraceful position. He began by doubting everything, but this doubt finally did run into something which could no longer be doubted, for, inasmuch as the doubter doubts, he cannot doubt that he is present and must be present in order to doubt at all. As I doubt I must admit that "I am." The

"I," accordingly, is the indubitable. As the doubter, Descartes forced men into doubt in this way; he led them to think of themselves, of their "I." Thus the "I," human subjectivity, came to be declared the center of thought. From here originated the I-viewpoint of modern times and its subjectivism. Philosophy itself, however, was thus brought to the insight that doubting must stand at the beginning of philosophy: reflection upon knowledge itself and its possibility. A theory of knowledge had to be erected before a theory of the world. From then on epistemology is the foundation of philosophy, and that distinguishes modern from medieval philosophy. Since then, the attempts to renew Scholasticism also strive to demonstrate the epistemology in their system, or to add it where it is missing, in order to make it usable for modern times. Accordingly, Plato and Aristotle are reinterpreted as epistemologists.

This story of Descartes, who came and doubted and so became a subjectivist, thus grounding epistemology, does give the usual picture; but at best it is only a bad novel, and anything but a story in which the movement of Being becomes visible.

The main work of Descartes carries the title *Meditationes de prima philosophia* (1641). *Prima philosophia*—this is the *prote philosophia* of Aristotle, the question concerning the Being of beings, in the form of the question concerning the thingness of things. *Meditationes de metaphysica*—nothing about theory of knowledge. The sentence or proposition constitutes the guide for the question about the Being of beings (for the categories). (The essential historical-metaphysical basis for the priority of *certainty*, which first made the acceptance and metaphysical development of the mathematical possible—Christianity and the *certainty of salvation*, the security of the individual as such—will not be considered here.)\*

\* See Martin Heidegger, *The End of Philosophy*, trans. Joan Stambaugh (New York: Harper & Row, 1973), pp. 19–26. For a more detailed treat-

In the Middle Ages, the doctrine of Aristotle was taken over in a very special way. In later Scholasticism, through the Spanish philosophical schools, especially through the Jesuit, Suárez, the "medieval" Aristotle went through an extended interpretation. Descartes received his first and fundamental philosophical education from the Jesuits at La Flèche. The title of his main work expresses both his argument with this tradition and his will to take up anew the question about the Being of beings, the thingness of the thing, "substance."

But all this happened in the midst of a period in which, for a century, mathematics had already been emerging more and more as the foundation of thought and was pressing toward clarity. It was a time which, in accordance with this free projection of the world, embarked on a new assault upon reality. There is nothing of skepticism here, nothing of the I-viewpoint and subjectivity—but just the contrary. Therefore, it is the passion of the new thought and inquiry to bring to clarification and display in its innermost essence the at first dark, unclear, and often misinterpreted fundamental position, which has progressed only by fits and starts. But this means that the mathematical wills to ground itself in the sense of its own inner requirements. It expressly intends to explicate itself as the standard of *all* thought and to establish the rules which thereby arise. Descartes substantially participates in this work of reflection upon the fundamental meaning of the mathematical. Because this reflection concerned the totality of beings and the knowledge of it, this had to become a reflection on metaphysics. This simultaneous advance in the direction of a foundation of mathematics and of a reflection on metaphysics above all characterizes his fundamental philosophical position. We can pursue this clearly in an unfinished early work which did not appear in print

ment, cf. Martin Heidegger, *Nietzsche*, two vols. (Pfullingen: G. Neske Verlag, 1961), II, 141–48 and ff.—Ed.

until fifty years after Descartes' death (1701). This work is called *Regulae ad directionem ingenii*.

(1) *Regulae*: basic and guiding propositions in which mathematics submits itself to its own essence; (2) *ad directionem ingenii*: laying the foundation of the mathematical in order that it, as a whole, becomes the measure of the inquiring mind. In the enunciation of something subject to rules as well as with regard to the inner free determination of the mind, the basic mathematical-metaphysical character is already expressed in the title. Here, by way of a reflection upon the essence of mathematics, Descartes grasps the idea of a *scientia universalis*, to which everything must be directed and ordered as the one authoritative science. Descartes expressly emphasizes that it is not a question of *mathematica vulgaris* but of *mathesis universalis*.

We cannot here present the inner construction and the main content of this unfinished work. In it the modern concept of science is coined. Only one who has really thought through this relentlessly sober volume long enough, down to its remotest and coldest corner, fulfills the prerequisite for getting an inkling of what is going on in modern science. In order to convey a notion of the intention and attitude of this work, we shall quote only three of the twenty-one rules, namely, the third, fourth, and fifth. Out of these the basic character of modern thought leaps before our eyes.

*Regula III*: "Concerning the objects before us, we should pursue the questions, not what others have thought, nor what we ourselves conjecture, but what we can clearly and insightfully intuit, or deduce with steps of certainty, for in no other way is knowledge arrived at."\*\*

*Regula IV*: "Method is necessary for discovering the truth of nature."

This rule does not intend the platitude that a science must also have its method, but it wants to say that the procedure, i.e., how in

\* Descartes, *Rules for the Direction of the Mind*, F. P. Lafleur, trans. (Liberal Arts Press, 1961), p. 8.—Tr.

general we are to pursue things (*methodos*), decides in advance what truth we shall seek out in the things.

Method is not one piece of equipment of science among others but the primary component out of which is first determined what can become object and how it becomes object.

*Regula V*: "Method consists entirely in the order and arrangement of that upon which the sharp vision of the mind must be directed in order to discover some truth. But, we will follow such a method only if we lead complex and obscure propositions back step by step to the simpler ones and then try to ascend by the same steps from the insight of the very simplest propositions to the knowledge of all the others."

What remains decisive is how this reflection on the mathematical affects the argument with traditional metaphysics (*prima philosophia*), and how, starting from there, the further destiny and form of modern philosophy is determined.

To the essence of the mathematical as a projection belongs the axiomatical, the beginning of basic principles upon which everything further is based in insightful order. If mathematics, in the sense of a *mathesis universalis*, is to ground and form the whole of knowledge, then it requires the formulation of special axioms.

(1) They must be absolutely first, intuitively evident in and of themselves, i.e., absolutely certain. This certainty participates in deciding their truth. (2) The highest axioms, as mathematical, must establish in advance, concerning the whole of beings, what is in being and what Being means, from where and how the thingness of things is determined. According to tradition this happens along the guidelines of the proposition. But up till now, the proposition had been taken only as what offered itself, as it were, of itself. The simple proposition about the simply present things contains and retains what the things are. Like the things, the proposition too is simply at hand and is the container of Being.

However, there can be no pre-given things for a basically mathematical position. The proposition cannot be an arbitrary

one. The proposition, and precisely it, must itself be based on its foundation. It must be a basic principle—the basic principle absolutely. One must therefore find such a principle of all positing, i.e., a proposition in which that about which it says something, the *subjectum* (*hypokeimenon*), is not just taken from somewhere else. That underlying subject must as such first emerge for itself in this original proposition and be established. Only in this way is the *subjectum* a *fundamentum absolutum*, purely posited from the proposition as such, a basis and ground established in the mathematical; only in this way is a *fundamentum absolutum* at the same time *inconcussum*, and thus indubitable and absolutely certain. Because the mathematical now sets itself up as the principle of all knowledge, all knowledge up to now must necessarily be put into question, regardless of whether it is tenable or not.

Descartes does not doubt because he is a skeptic; rather, he must become a doubter because he posits the mathematical as the absolute ground and seeks for all knowledge a foundation that will be in accord with it. It is a question not only of finding a fundamental law for the realm of nature, but finding the very first and highest basic principle for the Being of beings in general. This absolutely mathematical principle cannot have anything in front of it and cannot allow what might be given to it beforehand. If anything is given at all, it is only the *proposition* in general *as such*, i.e., the positing, the position, in the sense of a thinking that asserts. The positing, the proposition, has only itself as that which can be posited. Only where thinking thinks itself is it absolutely mathematical, i.e., a taking cognizance of that which we already have. Insofar as thinking and positing directs itself toward itself, it finds the following: *whatever* may be asserted, and in whatever sense, this asserting and thinking is always an “I think.” Thinking is always an “I think,” *ego cogito*. Therein lies: I am, *sum. Cogito, sum*—this is the highest certainty lying immediately in the proposition as such. In “I posit” the “I” as the positer is co- and pre-positioned as that which is already present, as the being. The Being of

beings is determined out of the “I am” as the certainty of the positing.

The formula which the proposition sometimes has, “*Cogito ergo sum*,” suggests the misunderstanding that it is here a question of inference. That is not the case and cannot be so, because this conclusion would have to have as its major premise: *Id quod cogitat, est*; and the minor premise: *cogito*; conclusion: *ergo sum*. However, the major premise would be only a formal generalization of what lies in the proposition: “*cogito—sum*.” Descartes himself emphasizes that no inference is present. The *sum* is not a consequence of the thinking, but vice versa; it is the ground of thinking, the *fundamentum*. In the essence of positing lies the proposition: I posit. That is a proposition which does not depend upon something given beforehand, but only gives to itself what lies within it. In it lies “I posit”: I am the one who posits and thinks. This proposition has the peculiarity of first positing that about which it makes an assertion, the *subjectum*. What it posits in this case is the “I.” The I is the *subjectum* of the very first principle. The I is therefore a special something which underlies [*Zugrundeliegendes*]—*hypokeimenon, subjectum*—the *subjectum* of the positing as such. Hence it came about that ever since then the “I” has especially been called the *subjectum*, “subject.” The character of the ego, as what is especially already present before one, remains unnoticed. Instead the subjectivity of the subject is determined by the “I-ness” [*Ichheit*] of the “I think.” That the “I” comes to be defined as that which is already present for representation (the “objective” in today’s sense) is not because of any I-viewpoint or any subjectivistic doubt, but because of the essential predominance and the definitely directed radicalization of the mathematical and the axiomatic.

This “I,” which has been raised to be the special *subjectum* on the basis of the mathematical, is in its meaning nothing “subjective” at all, in the sense of an incidental quality of just this particular human being. This “subject” designated in the “I think,” this I,

is subjectivistic only when its essence is no longer understood, i.e., is not unfolded from its origin considered in terms of its mode of Being.

Until Descartes every thing at hand for itself was a “subject”; but now the “I” becomes the special subject, that with regard to which all the remaining things first determine themselves as such. Because—mathematically—they first receive their thingness only through the founding relation to the highest principle and its “subject” (I), they are essentially such as stand as something else in relation to the “subject,” which lie over against it as *objectum*. The things themselves become “objects.”

The word *objectum* now passes through a corresponding change of meaning. For up to then the word *objectum* denoted what one cast before himself in mere fantasy: I imagine a golden mountain. This thus-represented—an *objectum* in the language of the Middle Ages—is, according to the usage of language today, merely something “subjective”; for “a golden mountain” does not exist “objectively” in the meaning of the changed linguistic use. This reversal of the meanings of the words *subjectum* and *objectum* is no mere affair of usage; it is a radical change of Dasein, that is to say, of the lighting of the Being of beings on the basis of the predominance of the *mathematical*. It is a stretch of the way of actual history necessarily hidden from the usual view, a history that always concerns the openness of Being—or nothing at all.

### 3. Reason as the highest ground: the principle of the I; the principle of contradiction

The I, as “I think,” is the ground upon which hereafter all certainty and truth are based. But thought, assertion, *logos*, is at the same time the guideline for the determinations of Being, the categories. These are found by the guideline of the “I think,” in viewing the “I.” By virtue of this fundamental significance for the foundation of all knowledge, the “I” thus becomes the accentuated and essential definition of man. Up to that time, and even later,

man was conceived as the *animal rationale*, as a rational living being. With this peculiar emphasis on the I, that is, with the “I think,” the determination of the rational and of reason now takes on a distinct priority. For thinking is the fundamental act of reason. With the *cogito-sum*, reason now becomes *explicitly* posited according to its own demand as the first ground of all knowledge and the guideline of the determination of the things.

Already in Aristotle the assertion, the *logos*, was the guideline for the determination of the categories, i.e., of the Being of beings. However, the locus of this guideline—human reason, reason in general—was not characterized as the subjectivity of the subject. But now reason is expressly set forth as the “I think” in the highest principle as guideline and court of appeal for all determinations of Being. The highest principle is the “I” principle: *cogito—sum*. It is the fundamental axiom of all knowledge; but it is not the only fundamental axiom, simply because in this I-principle itself there is included and posited with this one, and thereby with every proposition, yet another. When we say “*cogito—sum*,” we express what lies in the *subjectum* (*ego*). If the assertion is to be an assertion, it must always posit what lies in the *subjectum*. What is posited and spoken in the predicate may not and cannot speak against the subject. The *kataphasis* must always be such that it avoids the *antiphasis*, i.e., saying in the sense of speaking against, of contradiction. In the proposition as proposition, and accordingly in the highest principle as I-principle, there is co-posed as equally as valid the principle of the avoidance of contradiction (briefly: the principle of contradiction).

Since the mathematical as the axiomatic project posits itself as the authoritative principle of knowledge, the positing is thereby established as the thinking, as the “I think,” the I-principle. “I think” signifies that I avoid contradiction and follow the principle of contradiction.

The I-principle and the principle of contradiction spring from the essence of thinking itself, and in such a way that one looks

only to the essence of the “I think” and what lies in it and in it alone. The “I think” is reason, is its fundamental act; what is drawn solely from the “I think” is gained solely out of reason itself. Reason so comprehended is purely itself, pure reason.

These principles, which in accord with the fundamental mathematical feature of thinking spring solely from reason, become the principles of knowledge proper, i.e., philosophy in the primary sense, metaphysics. The principles of mere reason are the axioms of pure reason. Pure reason, *logos* so understood, the proposition in this form, becomes the guideline and standard of metaphysics, i.e., the court of appeal for the determination of the Being of beings, the thingness of things. The question about the thing is now anchored in pure reason, i.e., in the mathematical unfolding of its principles.

In the title “pure reason” lies the *logos* of Aristotle, and in the “pure” a certain special formation of the mathematical.